

# **SPECTRUM ANALYSIS OF THE MYOELECTRIC SIGNAL: A BIBLIOGRAPHY**

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For a number of years attempts have been made to use spectrum analysis of the myoelectric signal to relate characteristics of the signal to neuromuscular pathology. Some evidence has appeared for the shift to higher frequencies in various muscular dystrophies and a shift to lower frequencies in neuropathies, although the latter is not universally agreed upon. There does seem to be a shift to lower frequencies with muscle fatigue.

More recently, the development of control systems for externally powered prosthetic and orthotic devices has turned additional attention to the characteristics of the electromyogram, including its frequency spectrum. It has therefore seemed worthwhile to gather as complete as possible a list of articles which include spectrum analyses of the observed electrical signals from skeletal muscles.

In preparing this list an attempt was made to cover the published literature through 1970; it also includes a few publications from 1971. It does not include papers presented at meetings and printed only briefly in the special proceedings, nor reports, nor does it in general include publications with only a few comments rather than experimental data at a number of frequencies.

It must be noted that spectrum analysis is distinct from studies of spikes in the electromyogram. Articles on spike frequency (counts per second), distribution of time intervals between spikes, spike durations, or spike amplitudes, have been excluded from the present list. Also excluded are articles on synthesizing a signal which simulates that from the muscle. However, an article with frequency analysis of nerve action potentials is included (2).

Both surface and intramuscular electrodes have been used to obtain the signal, in different studies. Analyses of single-motor-unit action potentials as well as of interference patterns have been published. These results have been obtained using Fourier analysis, autocorrelation calculations, or frequency filters. The autocorrelation function is closely

related to the power spectrum; since cross-correlation is not, articles dealing only with cross-correlation have been excluded.

The earliest publication with data seems to be that of Walton (77). There seem to be only two publications in which amplitude spectra are reported: Vatchov et al. (76) and West, Funke, and Hart (79). The latter article is a study of birds and also includes frequency spectra. The only other data on non-human muscles seem to be those on the rabbit by Fex and Krakau (13) and Close, Maurer, and Poor (8). It is hoped that the following list will provide a useful source for those interested in further pursuing this aspect of electromyography.

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